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Abstract

The purpose of this study is to estimate costs and benefits and to compute alternative benefit-cost ratios for both the individuals and the Federal Government as a result of investing time and resources in the Training and Technology (TAT) Project. TAT is a continuing experimental program in training skilled workers for private industry. The five occupational areas included in the study are mechanical drafting, welding, machining, industrial electronics, and physical testing-quality control. Data were obtained by analyzing two samples of 70 persons each; one sample selected from 407 TAT trainees, the other sample from 1,500 qualified applicants not admitted because of limited space. The methodology, the cost of training to the Federal Government, the expected value of income differences between the trained and control groups by year, the expected value of tax differences accruing to the Federal Government by year, and the computation of the number of deductions per pay check are appended. (CH)

special report

Benefit-Cost Analysis of TAT Phase I Worker Training

TRAINING AND TECHNOLOGY PROJECT

Conducted at the U.S. Atomic Energy Commission's Oak Ridge, Tennessee, Y-12 Plant

- Oak Ridge Associated Universities
- Nuclear Division, Union Carbide Corporation
- Tennessee Division of Vocational-Technical Education
- Tennessee Department of Employment Security
- University of Tennessee
- Organized Labor

BENEFIT-COST ANALYSIS

OF

TAT PHASE I WORKER TRAINING

by
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July 1969
Oak Ridge, Tennessee

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PREFACE

This study is an analysis of the benefits and costs of the Training and Technology (TAT) Project, Oak Ridge, Tennessee. The five occupational areas included in the study are mechanical drafting, welding, machining, industrial electronics, and physical testing-quality control.

The computations of benefits and costs are based on two random samples of 70 individuals each and are controlled for educational level, martial status, and age. One random sample of 70 was selected from the 407 individuals who completed the training program. The other sample of 70, the control group, was selected from the approximately 1,500 applicants who appeared to be qualified in every aspect for the program and who completed the many hours of testing and interviewing, but were not admitted because of limited space.

The direct costs of training to the Federal Government were obtained from the records of the Nuclear Division, Union Carbide Corporation, and TAT. In addition, an estimate of the foregone tax payments of the trainees was included as a cost of training to the Federal Government for a total per trainee cost of $3,923. The costs of training to the individuals were the foregone income (determined by the control group's earnings obtained by questionnaire and verified by employer), adjusted by the probabilities of employment and of living as well as the amount of federal income taxes they would have paid had they been working. This was further reduced by the amount of the subsidy paid to the individual while undergoing training, for a total per trainee personal cost of $1,322.

The benefits accruing from training were computed by taking the income of both groups during year one and increasing it at annual compound rates of 3 and 6 percent to age 60. The 3 percent annual compound rate is the expected increase

in real income and the 6 percent annual compound rate assumes an annual rate of inflation of 3 percent. The income for each year was adjusted for the probabilities of living (determined from current mortality tables) and adjusted for unemployment (assuming the current rates for each group continue). This adjusted income was discounted to determine the rate of return to the individual trainee. The adjusted income, in conjunction with the 1968 tax schedule (including a 7.5 percent surtax), was used to compute the estimated tax payments of both groups, and this difference discounted to determine the rate of return to the Federal Government.

The results indicate that the rate of return to the individual is in excess of 200 percent. This high rate of return reflects the small personal investment per trainee ($1,322) in relation to the increase in average expected income during year one from $2,287 to $5,716, a net difference of $3,429. For each dollar of income foregone by the trainee, he received $2.60 during his first year of post-training employment. The rate of return for the Federal Government, based upon the discounted value of income tax differences, is 20.5 percent, assuming a 3 percent annual rate of income growth, and 25.7 percent assuming a 6 percent rate of income growth.

It is concluded, therefore, that the public investment in the TAT Project to assist workers in acquiring general skills is economically rational. The estimate of the economic benefit is actually an underestimate of the total social benefits.

Frederick Kirby, assistant professor of economics at the University of Tennessee, is a consultant to the Training and Technology Project. Paul Castagna, a student and research associate of Dr. Kirby, received his B.A. degree from UT in the Spring of 1969.

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CHAPTER 1

INTRODUCTION

Investment in human capital is a process rather than a goal. The quantifiable goals to which the creation of human capital contributes are increased economic opportunity for the individual and lower social costs, in the form of reduced welfare expenditures, and increased social benefits, by the amount of increased tax payments.

The purpose of this study is to estimate costs and benefits and to compute alternative benefit-cost ratios for both the individual and the Federal Government as a result of investing time and resources in the Training and Technology (TAT) Project, Phase I, Oak Ridge, Tennessee.

TAT is a continuing experimental program in training skilled workers for private industry.[1] Phase I, begun September 9, 1966, and concluded on June 28, 1968, consisted of two training cycles, of 52 and 42 weeks, respectively. The program is administered by Oak Ridge Associated Universities and is funded by the U. S. Office of Education and the U. S. Department of Labor, under interagency agreements with the U. S. Atomic Energy Commission.

Training is conducted within the gates of the Oak Ridge Y-12 Plant, a large industrial complex of the U. S. Atomic Energy Commission, operated for the AEC by the Nuclear Division, Union Carbide Corporation. The project is situated in a center of nuclear energy development and research with its supporting complex of sophisticated industrial installations.

Training during Phase I was provided in six occupational areas: mechanical drafting, machining, welding, industrial electronics, physical testing-quality control, and laboratory glass blowing. The latter area group was not, however, included in this study and training in glass blowing was discontinued at the conclusion of Phase I.

Phase I concentrated upon high school graduates who were primarily underemployed, working in low-skilled, dead-end jobs. As part of the experimentation, trainees with lesser educational qualifications were included in both cycles. More than half of the trainees were economically disadvantaged, with incomes below the poverty line. Experimentation is continuing in Phase II, and more than 75 percent of the trainees in this group meet the "disadvantaged" definition of the Department of Labor by being poor and lacking suitable employment and one of the following: under 22 or over 45 years of age, member of a minority group, school dropout, or handicapped.[2]

Quantification of the economic aspects of education does not imply that education consists of only tangible elements. Some of the more important non-quantifiable elements of education are better citizenship, reduction of crime, and increased labor mobility. These externalities which accompany vocational as well as formal education imply that an approximation of the economic return from vocational training is an underestimate of the real rate of return. Thus, an economic analysis of alternative public investments is not meant to be the sole basis of decision-making, but it is one important element to be considered.

The increasing importance of the public sector in the national economy has increased the competitiveness of different governmental agencies and departments vying for a limited supply of funds to expend on socially desirable investments. This intensified competition, combined with mounting pressure for increased efficiency in government spending, has enhanced the importance in decision-making of estimates of the relative profitability among alternative public investments.

This study is an attempt to estimate the profitability of one form of public investment and, thereby, to supply the economic information which is significant for the decision-making process.

1. Summary Report, Phase I Activities, June 1966 - September 1968, prepared by Oak Ridge Associated Universities, Oak Ridge, Tennessee.

2. Training and Technology Project - Phase II, Periodic Report, To: U. S. Department of Labor, Reporting Period: January 1 - March 31, 1969, prepared by Oak Ridge Associated Universities, Oak Ridge, Tennessee.

CHAPTER 2

ANALYTICAL PROCEDURE

The purpose of this study is to estimate costs and benefits for the trainees and federal government for investing time and resources in the Training and Technology (TAT) Project at Oak Ridge, Tennessee. The methodology used in computing benefits and costs is described in Appendix A. Appendix B presents the costs of training to the federal government; Appendix C, the expected value of income differences between the trained and control groups, by year; Appendix D, the expected value of tax differences accruing to the federal government, by year; and Appendix E, the computation of the number of deductions per paycheck.

Investment in education results in increased consumption, some of which may be estimated by income and some of which is nonquantifiable (e.g., literacy and better citizenship). Formal education has a larger nonquantifiable effect upon consumption, whereas technical education is more job oriented[1], so that the estimation of the benefits of technical education is closer to the total value than the estimation of formal education benefits.

The tool the economist applies to public investments is a discount rate to estimate the profitability of the investment. Theoretical considerations suggest a 5 percent and 10 percent profitability rate as describing the boundaries of the minimum range within which public investment is justified by economic considerations.[2] The application of a discount rate can take

two forms: the internal rate of return and benefit-cost ratios. The internal rate of return implies that capital is the constraining factor, whereas the benefit-cost ratio implies that federal government spending based on political decisions is the constraining factor. Thus, the internal rate of return maximizes "present worth for a given investment budget,"[3] while the benefit-cost ratio emphasizes present consumption versus future consumption.[4]

The internal rate of return and benefit-cost analyses do not give the same order of ranking. Otto Eckstein illustrates that benefit-cost analysis favors investments which require large amounts of initial capital, whereas the internal rate of return favors those projects with little initial capital but large flows of income and recurring costs.[5]

The controversy over the internal rate of return versus the benefit-cost analysis has not been resolved. Recognizing the important issues raised by both sides, we have presented the benefit-cost ratios at various discount rates and have computed the internal rate of return for the federal government. By presenting both methods, the decision-maker can choose the one which he feels is appropriate.

The computation of benefits and costs was aided by TAT's maintenance of detailed records of each trainee's social, educational, and economic characteristics which were updated six months and 18 months after the trainee left the program. In addition, detailed information is available for approximately 1,500 applicants who completed all forms, interviews, and examinations and appeared to be qualified in every aspect for acceptance

into the TAT program, but were not selected because of the limited number of positions available. These 1,500 who were qualified for the program are a portion of the more than 5,000 who initially applied for the program.

One-hundred eighty-eight applicants were selected by use of a random number table from the 1,500 qualified for the program. The mean age and education as well as the variances of these two variables are not significantly different from the trained group at the 1 percent level of significance. There is no control for motivation factors among individuals, so the implied assumption is that, since these 188 completed the many hours of interviews and testing, they are motivated similarly to the trained group.

Follow-up questionnaires were sent to the 188 nontrainees. Eighty-six questionnaires were returned and of these 16 could not be used. Thus the control group consisted of 70 individuals and the same size group was drawn from the trainees. Group statistics are given in Table I.

TABLE I

TRAINED AND CONTROL GROUP STATISTICS

(Sample size of each group: 70)

	Trained	Control
* Mean Age	24	25.4
* Variance	127	135
* Mean Years of Formal Education	12	12
* Variance	1.01	1.03
Unemployed	2%	27%

* No significant difference between the trained and control groups at the 1 percent level of significance.

Unemployment rates for the two groups reflect several factors, and among the more important are the following:[6] a shortage of skilled workers; efficient placement services for the trainees (each trainee averaged three job offers); surplus of unskilled labor, which includes geographical unemployment (simply not being where unskilled labor demand exists);[7] lack of mobility of unskilled labor; and failure of the private sector to train an adequate number of workers in needed skills.[8]

The costs and benefits of education are different when measuring the returns to the federal government and to the individual. The costs to the federal government are direct costs and are merely summed (once the costs of teachers' salaries have been reduced by the proportion of time spent upon direct production activities).

Since the federal government pays the entire amount of direct costs, the cost to the individual trainee is in the form of opportunity cost. This opportunity cost is the expected value of the trainee's earnings[9] (had he decided to work rather than undergo training), including fringe benefits (fringe benefits are assumed to be 12 percent of the individual's income)[10] but not taxes.[11] (This study assumes two deductions for tax purposes, as discussed in Appendix E.) In addition to the trainee's opportunity cost being reduced by the amount of taxes, the amount of direct subsidies paid to the trainee while undergoing training must also be deducted. Direct subsidies reduce the costs of training to the individual but increase the cost to the federal government in the same manner as the tax not paid by the individual is a reduction in his opportunity cost but, again, an increase in the cost of training to the federal government.

The major benefit to the federal government is the differential of the expected value of tax revenues and, to the individual, the expected value of differential income flows. In addition to the increase in tax revenues being a benefit to the federal government, the reduction in welfare payments attributable to the training program is also a benefit. Since the State of Tennessee does not have general welfare payments, this factor was not included in the computations. In states where general welfare payments do exist, inclusion of these payments would be expected to significantly increase the rate of return to the federal government and reduce the return to the individual.

The absence of general welfare payments may increase the nonquantifiable social costs of the absence of retraining opportunities. For instance, if the number of unskilled workers exceeds the number of unskilled jobs so that employment is simply not available, the individual may resort to crime to obtain a cash income. The absence of this factor in computing the benefits to the federal government results in an underestimate of benefits.

The benefit of training to the individual is the difference in the expected value of income flow. Both the trained and control groups are expected to experience increasing incomes over their working lives. This income increase is included in the computations at 3 percent and 6 percent annual compounded rates. The 3 percent rate approximates the benefits in real terms (constant value dollars); the 6 percent compounded rate of increase assumes a 3 percent annual rate of inflation and approximates the return in inflated dollars. As stated above, a reduction in welfare payments must

be subtracted from the earned income differences. It reduces the economic value of training to the individual and must be reflected in the rate of return.

Another nonquantifiable factor which increases the economic benefit to the individual but is not included in the computations is the hedging option.[12] With rapid technological change, adaptability to new processes becomes important. Training can be viewed as a hedge against technological displacement because individuals already possessing skills are the most likely to receive on-the-job training to acquire the techniques of operating the new technology.

This study considers the expected values of income and tax differences accruing to the federal government and to the individual trainee. These expected values are derived by using appropriate probabilities to determine the expected values and then discounting these expected values of annual flow of income to the present to equate present cost with present value. This study uses an increasing rate of discount until the benefit-cost ratio equals unity, at which point the discount rate equals the internal rate of return. Since both the benefit-cost ratios at various rates of discount and the internal rate of return are presented, the decision-maker can base his decision on either method he feels is appropriate. The various benefit-cost ratios and the internal rate of return are presented in the following chapter on results of the study.

1. Adger B. Carrol and Loren A. Ihnen, "Costs and Returns for Two Years of Postsecondary Technical Schooling: A Pilot Study," Journal of Political Economy, LXXV (December, 1967), pp. 862-73.

2. Burton A. Weisbrod, "Conceptual Issues in Evaluating Training Programs," Monthly Labor Review, XXCIX (October, 1966), p. 1097.

3. Roland N. McKean, Efficiency in Government Through Systems Analysis. Wiley & Sons, Inc., New York, 1958, p. 117.

4. Otto Eckstein, Water Resource Development: The Economics of Project Evaluation. Harvard University Press, Cambridge, Massachusetts, 1965, p. 70.

5. Ibid., p. 54-55.

6. We had initially thought that a portion of the difference in the unemployment rate might be explained by the selection procedure for training being prejudiced against single males and a higher proportion of those not selected being single, thereby having a lower incentive to obtain employment. However, this is not true: 38 of the 70 trainees are single and 33 of 70 in the control group are single.

7. Continued automation and the effect upon "twisting" labor demand may be reflected in the differences of unemployment rates and thereby continuing this large difference. For a discussion of "twisting" labor demand, see Charles C. Killingsworth, "Unemployment With Labor Shortages" in Contemporary Labor Issues, by Walter Fogel and Archie Kleingartner (eds.) (Wadsworth Publishing Company, Inc., Belmont, California, 1966).

8. The reason the private sector does not provide a sufficient number of workers trained in "general" skills is thoroughly discussed by Gary Becker, Human Capital. Columbia University Press, New York, 1964, pp. 9-28.

9. Rates of return may be reduced by as much as 60 percent when foregone earnings are considered part of costs. See Theodore W. Schultz, The Economic Value of Education. Columbia University Press, New York, 1963, p. 5.

10. The follow-up questionnaires did not include a question pertaining to the amount of fringe benefits; however, this information was obtained from the employer at the same time that the answers to the questionnaires were being verified. The proportion of fringe benefits varies from 0 percent to 28 percent, with a mean of 12 percent and a median of 12.5 percent. The 12 percent used in this study is thought to be an overestimate for the untrained group and an underestimate for the trained group.

11. The tax foregone by the federal government was the amount paid by the control group during the training period.

12. Burton A. Weisbrod, External Benefits of Public Education. Princeton University Press, Princeton, New Jersey, 1964, p. 23.

CHAPTER 3

RESULTS

The benefit-cost ratios are arrived at by discounting the expected value of tax and income flows for each of the 35 years of remaining working life[1] at various rates. The internal rate of return is that interest rate which equates the present cost with the present value of the future flow of benefits. These benefit-cost ratios and the internal rate of return for the federal government are presented in Table II. The benefit-cost ratios for the trainees are presented in Table III.

TABLE II

BENEFIT-COST RATIOS AT SELECTED RATES FOR INCOMES
BASED ON 3% AND 6% GROWTH
(Federal Government)

Total Costs (Investment) - $274,610

Discount Rate	B/C Ratio Earnings at 3%	B/C Ratio Earnings at 6%
5%	4.932	11.718
10%	2.430	4.710
15%	1.475	2.408
20%	1.029	1.488
25%	.785	1.046
Internal Rate of Return	20.49%	25.74%

TABLE III

BENEFIT-COST RATIOS AT SELECTED RATES FOR INCOMES
BASED ON 3% AND 6% GROWTH
(Trainees)

Total Costs (Investment) - $92,525

Discount Rate	B/C Ratio Earnings at 3%	B/C Ratio Earnings at 6%
50%	5.491	5.981
100%	2.668	2.819
150%	1.762	1.844
200%	1.315	1.363

The various rates of discount stated in Tables II and III are under-estimates, as the external costs to society as well as nonquantifiable benefits to the federal government and the individual are not included in the computations. These omissions do not invalidate benefit-cost analysis as a tool of decision-making.

Pure economic feasibility of any government investment is only one vital aspect of decision-making. Given results of an economic analysis adverse to a government investment, the investment may well be justified on a social basis--which is one important function of the political decision-making process. The point is that economic feasibility is a vital but not a singular investment decision tool.

Contrary to popular belief, vocational training is not a welfare function. However, it does have important implications for the degree of income inequality. Excluding external benefits, the federal government earned a real rate of return in excess of 20 percent for investing time and resources in Phase I of the TAT Program. To the extent that TAT provided the labor market with needed skills, a more efficient allocation of labor has been achieved.

1. The average age of the trainees is 25 years and retirement is assumed to occur at age 60. Thus, the anticipated remaining working life is 35 years.

APPENDIX A

Methodology

The notations used in the formulation of the benefit-cost analysis are as follows:

C_i, costs of training to the individual

C_g, costs of training of each individual to the federal government

Y_{ed}, earned income difference accruing to the individual for each year of work after completion of training

Y_g, income accruing annually to the federal government in the form of increased tax payments

Y_{at}, annual earned income of each trainee after training (hourly wage times 40 hours per week times 52 weeks)

Y_{ec}, earned income of each individual in the control group during the time the trainees undergo training

Y_w, reduction in individual welfare transfers accounted for by the training

P_l, probable life expectancy which will decrease with each additional year of working life

P_e, probability of being employed which, once estimated is assumed to be constant (subscript t refers to the trained group, 98 percent employment and c to the control group, 73 percent employment)

P_i, probability of not being injured on the job (resulting in time lost) which is a constant

P_r, probability that the trainee will be placed in a job for which he was trained

P_{pr}, probability that the trainee would have been trained in an economically equivalent skill or would have attained an equivalent income without incurring federal government expense

S_a, total wages and salaries paid to administrative and executive personnel

S_t, total wages and salaries paid to shop personnel, including the entire teaching staff. (The total cost of this group is reduced by the proportion of time spent on direct production activities [ ].)

O, other costs of training including maintenance, medical facilities, stores, insurance, cafeteria, guards, parking lots, etc.

M_{me}, costs of machinery, materials, and equipment

D, direct subsidies paid by the federal government to the individual trainee while undergoing training

T, total number of trainees in program (407).

T_t, total number of trainees in sample (70).

T_c, total number of nontrainees in control group sample (70).

1.03, 3% annual increase in real income during each year of the individuals' working lives

1.06, 6% annual increase in money income (assuming an annual rate of inflation of 3%) during the remainder of the individuals' working lives

1.12, 12% fringe benefits not included in the regular pay check

T_{xt}, federal income taxes paid by each individual in the trained group. (The computation of taxes paid by the trained and control samples is based upon the 1968 tax table which has an effective surtax rate of 7.5%.)

T_{xc}, taxes paid each year by each individual in the control group

T_f, tax payments foregone by the federal government because of the individuals' undergoing training rather than working and receiving a regular paycheck

j, number of years of working life remaining for the trained group. Average age of trainees upon completion of training is 25 years. Assuming retirement will occur at 60 years of age, j varies from 1 to 35.

The methods of computing the benefits and costs to the individual and the federal government are specified in the following formulations.

The computation of costs of training to the trainees is as follows:

$$(1)\quad \sum_{i=1}^{T_t} C_i = \sum_{i=1}^{T_c} (Y_{ec} \times 1.12 - T_{xc})\,(P_{l_j} \times P_{ec} \times P_i) - \sum_{i=1}^{T_t} D/T \text{ , and } T_t = T_c$$

The cost of training to the individual trainee is an opportunity cost. This cost includes the amount he could have earned by working (to include fringe benefits) minus taxes paid. This net amount times the appropriate probabilities gives the expected value of this foregone income. This expected value minus subsidies received while undergoing training is the opportunity cost to the individual.

P_i, the probability of not incurring a time loss caused by an on-the-job injury, is not included in the empirical portion as its inclusion would not have had a significant effect upon the results obtained.[1]

The costs of training to the federal government are direct costs and are computed as follows:

$$(2) \quad \sum_{i=1}^{T_t} C_g = \sum_{i=1}^{T_t} \left[(S_a + S_t (1 - \alpha) + M_{me} + D + B_u + O)/T \right] + \sum_{i=1}^{T_c} T_{xc}$$

The cost of training the seventy individuals in the sample is total costs of all training divided by the total number of trainees. This amount is then summed over the seventy individuals in the sample. In addition, the federal government had foregone tax revenues during the time the trainees were undergoing training as opposed to their being employed in a regular paid job. The direct costs are detailed in appendix B.

The benefits which accrue to both the individual (see appendix C) and the federal government (see appendix D) must be computed on an annual basis and summed over time from completion of training until retirement. (It will be assumed that retirement will occur at age sixty.) The following formulation specifies the expected earned income difference:

$$(3) \quad \sum_{i=1}^{T_t} Y_{ed_j} = \sum_{i=1}^{T_t} (Y_{at_j} \times 1.12 \times (1.03)^j - T_{xt_j}) (P_{l_j} \times P_{e_t} \times P_i \times P_r)$$

$$- \sum_{i=1}^{T_c} (Y_{ec_j} \times 1.12 \times (1.03)^j - T_{xc_j}) (P_{l_j} \times P_{ec} \times P_i)$$

$$- \sum_{i=1}^{T_t} (Y_w \times P_{l_j})$$

Let $\sum_{i=1}^{T_t} Y^*_{at_j}$ equal the first term to the right of the equal sign; $\sum_{i=1}^{T_c} Y^*_{ec_j}$ equal the second term; and $\sum_{i=1}^{T_t} Y^*_{w}$ the third term. Then:

$$(4) \quad \sum_{i=1}^{T_t} Y_{ed_j} = \sum_{i=1}^{T_t} Y^*_{at_j} - \sum_{i=1}^{T_c} Y^*_{ec_j} - \sum_{i=1}^{T_t} Y^*_{w}$$

The above equation specifies that the expected value of earned income differences each year is the expected value of earned income of the trained group minus the expected value of the earned income of the control group and the lost welfare payments of the trained group. P_r in equation (3) is equal to 1; 99.6 percent of all trainees were placed in jobs.

The benefit to the federal government is the expected value of the additional tax payments resulting from the investment in training. Because of increasing marginal tax rates with rising incomes, a proper estimate of expected additional tax revenue differences accruing to the federal government includes these tax payments reduced by the appropriate probabilities rather than the incomes reduced by the appropriate probabilities and the taxes computed on this expected income. The following formulation is used to compute the benefit to the federal government:

$$(5) \quad \sum_{i=1}^{T_t} Y_{g_j} = \sum_{i=1}^{T_t} T_{xt_j} \times P_{l_j} \times P_{et} \times P_{pr} - \sum_{i=1}^{T_c} T_{xc_j} \times P_{l_j} \times P_{ec} + \sum_{i=1}^{T_t} Y_w \times P_{l_j}$$

Let $\sum_{i=1}^{T_t} T^*_{xt_j}$ equal the firm term to the right of the equal sign; $\sum_{i=1}^{T_c} T^*_{xc_j}$ equal the second term; and $\sum_{i=1}^{T_t} Y^*_{w}$ equal the third term. Then:

$$(6)\quad \sum_{i=1}^{T_t} Y_{g_j} = \sum_{i=1}^{T_t} T^*_{Xt_j} - \sum_{i=1}^{T_c} T^*_{Xc_j} + \sum_{i=1}^{T_t} Y^*_w$$

The above equation states that the benefit to the federal government each year is the increase in tax revenues plus the reduction in welfare transfers.[2]

The computation of the benefit-cost ratios are the various rates of interest applied to the future stream of income. They are specified in the text and are computed in the following manner:

For the individual:

$$(7)\quad \sum_{i=1}^{T_t} C_i = \sum_{i=1}^{j} \sum_{i=1}^{T_t} Y_{ed_j} \frac{1}{(1+r)^j}$$

For the federal government:

$$(8)\quad \sum_{i=1}^{T_t} C_g = \sum_{i=1}^{j} \sum_{i=1}^{T_t} Y_{g_j} \frac{1}{(1+r)^j}$$

1. The Tennessee injury rate in manufacturing in 1967 was computed on a basis of 1,000,000 man hours worked. The average length of absence due to accidental injury was 19.6 days. The expected number of hours worked per year by the control group is approximately 100,000. One-hundred thousand is 10 percent of 1,000,000; and this percentage times the average days of absence per injury is 1.96, or two days of work lost each year because of on-the-job injuries. The omission of P_i does not significantly effect the results obtained. Source of data is State of Tennessee, Annual Report of the Department of Labor, for the fiscal year ending June 30, 1968.

2. P_{pr} was not used in the empirical portion of this study as a proper estimate could not be obtained. An appropriate estimate of this probability would necessitate an estimate of upgrading through on-the-job training and what proportion on-the-job training is of total training and this proportion reduced by the appropriate probabilities to obtain an estimate of P_{pr}.

APPENDIX B

COSTS OF TRAINING

Wages and Salaries of Executives and Administrative Personnel	$ 146,269
Wages and Salaries of Shop Personnel and Teachers	108,964
Machinery and Equipment	89,912
Materials	69,445
Direct Subsidies Paid to Trainees	700,616
Building Depreciation	34,633
Utilities	34,000
Project Administration	20,267
*Other (General Administrative)	221,230
Total Costs	$1,425,336

Cost per Individual ($1,425,336/407) = $3,502

Training Costs for Sample of 70 (70 x 3,502) =	$ 245,140
**Foregone taxes during Training Period	28,470
Total Cost of Training 70 People	$ 274,610

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* Including maintenance, medical, insurance, cafeteria, parking and dormitory facilities, stores, and guards.

** Foregone taxes represent the taxes paid during the training period by the control group

Source: Primary

APPENDIX C

EXPECTED VALUE OF EARNINGS COMPOUNDED AT 3%

YEAR	Annual Income of Trainees $\sum_{i=1}^{T_t} Y^*_{at_j}$	Annual Income of Control Group $\sum_{i=1}^{T_c} Y^*_{ec_j}$	Annual Income Differences $\sum_{i=1}^{T_t} Y^*_{at_j} - \sum_{i=1}^{T_t} Y^*_{ec_j}$
1	$ 400,111	$ 160,095	$ 240,015(1)
2	411,279	164,596	246,683
3	422,729	169,217	253,512
4	434,443	173,954	260,490
5	446,394	178,865	267,529
6	458,721	183,880	274,841
7	471,444	188,971	282,473
8	484,416	194,208	290,208
9	498,709	199,589	299,121
10	512,109	205,113	306,996
11	526,058	210,845	315,213
12	540,402	216,814	323,588
13	554,807	222,790	332,017
14	569,771	228,958	340,813
15	584,981	235,214	349,767
16	600,235	241,570	358,665
17	616,089	248,152	367,937
18	632,631	254,873	377,758
19	648,960	261,801	387,158
20	665,774	268,841	396,932
21	683,214	276,050	407,164
22	700,689	283,418	417,271
23	718,472	290,900	427,572
24	736,542	298,717	437,825
25	754,995	306,483	448,512
26	774,120	314,742	459,378
27	793,286	322,969	470,317
28	812,856	331,223	481,633
29	832,867	339,793	493,073
30	853,303	348,594	504,709
31	874,059	357,436	516,624
32	895,074	366,433	528,640
33	916,278	375,908	540,370
34	937,794	385,080	552,714
35	959,562	394,354	565,209

(1) During year one the average income of each member of the control group was $2,287 while the average income of each member of the trained group was $5,716, resulting in an average net income difference of $3,429.

EXPECTED VALUE OF EARNINGS COMPOUNDED AT 6%

YEAR	Annual Income of Trainees $\sum_{i=1}^{T_t} Y^*_{at_j}$	Annual Income of Control Group $\sum_{i=1}^{T_c} Y^*_{ec_j}$	Annual Income Differences $\sum_{i=1}^{T_t} Y^*_{at_j} - \sum_{i=1}^{T_t} Y^*_{ec_j}$
1	$ 410,961	$ 164,466	$ 246,495
2	433,809	173,695	260,115
3	457,747	183,486	274,261
4	483,077	193,663	289,414
5	510,425	204,411	306,014
6	538,297	215,909	322,388
7	567,429	227,917	339,512
8	597,611	240,463	357,149
9	629,308	253,606	375,702
10	662,721	267,543	395,177
11	697,608	282,073	415,535
12	733,566	297,347	436,219
13	771,488	313,582	457,907
14	810,638	330,200	480,438
15	851,506	347,680	503,826
16	894,056	365,820	528,236
17	938,375	385,173	553,202
18	984,522	404,807	579,715
19	1,032,236	425,304	606,932
20	1,081,599	446,685	634,914
21	1,132,712	469,118	663,594
22	1,185,750	492,346	693,404
23	1,240,841	516,381	724,460
24	1,298,148	541,360	756,788
25	1,357,444	567,381	790,063
26	1,419,376	594,327	825,049
27	1,484,061	622,360	861,700
28	1,551,484	651,587	899,897
29	1,621,971	681,809	940,162
30	1,695,590	713,342	982,248
31	1,771,820	746,070	1,025,750
32	1,851,179	780,037	1,071,142
33	1,933,268	815,101	1,118,167
34	2,018,510	851,548	1,166,962
35	2,106,890	889,509	1,217,381

APPENDIX D

EXPECTED VALUE OF TAXES BASED ON EARNINGS COMPOUNDED AT THE RATE OF 3%

YEAR	Annual Federal Tax Payments of Trainees $\sum_{i=1}^{T_t} T^*_{xt_j}$	Annual Federal Tax Payments of Control Group $\sum_{i=1}^{T_c} T^*_{xc_j}$	Annual Federal Tax Payment Differences $\sum_{i=1}^{T_t} T^*_{xt_j} - \sum_{i=1}^{T_c} T^*_{xc_j}$
1	$ 68,238	$ 23,437	$ 44,801
2	71,116	24,441	46,675
3	74,118	25,483	48,635
4	77,278	26,575	50,703
5	80,642	27,666	52,976
6	84,083	28,829	55,255
7	87,593	30,100	57,493
8	91,335	31,412	59,923
9	94,249	32,775	61,475
10	98,558	34,190	64,368
11	102,835	35,600	67,235
12	107,234	36,976	70,257
13	112,117	38,559	73,559
14	116,997	40,166	76,830
15	122,198	41,909	80,289
16	127,940	43,781	84,159
17	133,692	45,666	88,026
18	139,371	47,652	91,719
19	145,899	49,681	96,218
20	152,594	51,854	100,741
21	159,324	54,116	105,208
22	166,670	56,475	110,195
23	174,369	58,978	115,391
24	182,464	61,416	121,048
25	190,875	64,176	126,699
26	199,361	66,738	132,624
27	208,621	69,650	138,972
28	218,318	72,865	145,453
29	228,415	76,093	152,322
30	238,944	79,427	159,517
31	249,954	83,033	166,921
32	261,453	86,776	174,677
33	273,482	90,324	183,157
34	285,943	94,468	191,475
35	298,965	98,828	200,138

EXPECTED VALUE OF TAXES BASED ON EARNINGS COMPOUNDED AT THE RATE OF 6%

YEAR	Annual Federal Tax Payments of Trainees $\sum_{i=1}^{T_t} T^*_{xt_j}$	Annual Federal Tax Payments of Control Group $\sum_{i=1}^{T_c} T^*_{xc_j}$	Annual Federal Tax Payment Differences $\sum_{i=1}^{T_t} T^*_{xt_j} \quad \sum_{i=1}^{T_c} T^*_{xc_j}$
1	$ 71,030	$ 24,412	$ 46,618
2	77,096	26,514	50,582
3	83,790	28,727	55,063
4	90,918	31,269	59,649
5	97,968	34,001	63,967
6	106,548	36,787	69,761
7	116,045	39,917	76,128
8	126,798	43,412	83,386
9	138,482	47,269	91,213
10	151,030	51,342	99,688
11	164,838	55,894	108,943
12	180,453	60,831	119,622
13	197,168	66,007	131,161
14	215,890	72,067	143,823
15	236,320	78,607	157,712
16	258,691	85,908	172,782
17	283,146	93,505	189,640
18	309,834	102,414	207,420
19	339,259	112,145	227,113
20	371,587	122,776	248,811
21	406,969	134,239	272,730
22	445,457	146,878	298,580
23	487,196	160,788	326,409
24	532,336	175,954	356,382
25	581,422	192,405	389,017
26	634,207	210,413	423,794
27	691,048	230,001	461,046
28	752,362	251,225	501,137
29	818,205	274,427	543,779
30	888,932	299,458	589,474
31	965,335	326,542	638,793
32	1,047,177	355,747	691,431
33	1,135,222	387,352	747,870
34	1,229,534	421,267	808,267
35	1,330,787	457,618	873,169

APPENDIX E

Dependents per Paycheck

The current number of dependents for the trainees and the control group does not reflect an appropriate estimate, because the mean age of both groups is 24 and 25, respectively. An accurate estimate of the number of dependents is important in computing the increase in tax payments accruing to the federal government. The following procedure is used to arrive at the appropriate number of dependents per paycheck.

The trained and control group samples consisted of 70 individuals, and of these 70, 8 percent are expected to remain single.[1] So 5.6 (or six) individuals are expected to remain single and 64 individuals are expected to be members of primary families. These 64 individuals in each group will have an average population per household of 3.28 members.[2] In addition, a female labor force participation rate of 50 percent is implied in both groups.[3]

At any one point in time the expected number of individuals who will be members of the households of the trained and control groups is the number of primary families times the average population per household plus the six single individuals, or a total of 216 people. Assuming a female labor force participation rate of 50 percent, the total number of income payments supporting these 216 people will be 102. Two-hundred-sixteen people dependent upon 102 incomes gives an expected number of dependents of 2.2. Thus, two dependents is used as the appropriate number of deductions for computation of income taxes paid by both groups.

1. Statistical Abstract of the U.S., 1968, Table 36. Eight percent of males between the ages of 35 and 44 are single. This is lower than the two preceeding age groups which are : 30 to 34, 11.7 percent; and 25 to 29, 15.2 percent. Thus, 8 percent is an underestimate of the expected number of single males in both groups for the next two decades.

2. Ibid., table 39.

3. William G. Bowen and T. Aldrich Finegan, "Educational Attainment and Labor Force Participation," The American Economic Review, LVI (May 1966), p. 579. The sample of females used in the Bowen and Finegan study included only married women, 18-64, with husband present, who had no children under six and excluded women under 35 who were still enrolled in school. Since 50 percent of both sample groups are single, we do not really know what female population we are dealing with. However, we assume that the educational levels of the wives will approximate that of the males; thus the appropriate female labor force participation rate will be that for high school graduates.

BIBLIOGRAPHY

Reports

Summary Report, Phase I Activities; June 1966 - September 1968. Prepared by Oak Ridge Associated Universities. Oak Ridge, Tenn.: 1969.

Training and Technology Project - Phase II, Period Report; January through March 1969. Prepared by Oak Ridge Associated Universities for the Department of Labor. Oak Ridge, Tenn.: 1969.

State of Tennessee, Annual Report of the Department of Labor. Nashville, Tenn.: 1968.

Public Documents

Statistical Abstract of the United States, 1968.

Books

Becker, Gary. Human Capital. New York: Columbia University Press, 1964.

Eckstein, Otto. Water Resource Development: The Economics of Project Evaluation. Cambridge, Mass.: Harvard University Press, 1965.

McKean, Roland N. Efficiency in Government Through Systems Analysis. New York: John Wiley and Sons, Inc., 1958.

Schultz, Theodore W. The Economic Value of Education. New York: Columbia University Press, 1963.

Weisbrod, Burton A. External Benefits of Public Education. Princeton, N.J.: Princeton University Press, 1964.

Articles

Bowen, William G., and Finegan, Aldrich. "Educational Attainment and Labor Force Participation," American Economic Review, LVI (May 1966).

Carrol, Adger B., and Ihnen, Loren A. "Costs and Returns for Two Years of Postsecondary Technical Schooling: A Pilot Study," Journal of Political Economy, LXXV (December 1967).

Weisbrod, Burton A. "Conceptual Issues in Evaluating Training Programs," Monthly Labor Review, XXCIX (October 1966).